

AK-RD-87-13

RESEARCH AND DEVELOPMENT  
PROGRESS IN 1986

AN ANNUAL REPORT

FOR

THE RESEARCH SECTION

OF

ALASKA DEPARTMENT OF TRANSPORTATION  
AND PUBLIC FACILITIES  
2301 PEGER ROAD  
FAIRBANKS, ALASKA 99709

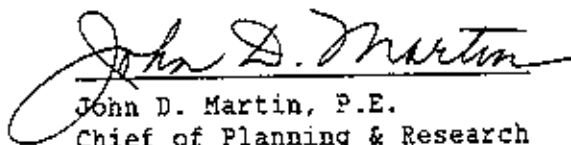
JULY 1987

## FORWARD

This report covers a period of substantial change to the Research organization. Changes have occurred in the reporting relationship and in the internal organization as a result of a series of deep budget cuts and staff reductions.

The last annual report covered the period ending July, 1985. This report takes off from that point and provides most financial statistics through the calendar year 1986. This document is intended to make available background information for the 1987 annual Research Advisory Board Meeting scheduled for August.

In recent years, the Research Section has been organized into two major program areas: Highways and Facilities. Research programs are discussed in that context. However, beginning with the 1987 Research Advisory Board Meeting, Statewide Research will be moving to a consolidated program. The 1987 Research Advisory Board Meeting represents a change from previous years when separate advisory boards met to consider new ideas for Highways and Facilities Program areas.

  
John D. Martin, P.E.  
Chief of Planning & Research

## 1 RESEARCH AT DOT&PF

### 1.1 INTRODUCTION

The Research Section is a subdivision of the Alaska Department of Transportation and Public Facilities (DOT&PF). The offices and laboratories are located in the Duckering Building on the Campus of the University of Alaska, Fairbanks, Fairbanks, Alaska. Business hours are 7:30 AM to 4:00 PM week days. The telephone numbers are (907) 474-2470 & 474-2480. The telecopy number is (907) 474-2466. Mail for the Research Section is processed through the Department's Northern Region office. The correct mailing address is:

Research Section  
Alaska Department of Transportation  
and Public Facilities  
2301 Peger Road  
Fairbanks, AK 99709

### 1.2 JUSTIFICATION

A Research Section is maintained within DOT&PF to provide for certain statutory responsibilities which can be generally described as Technology Assessment. Citations found in the Alaska statutes which apply to several DOT&PF responsibilities covered by the Research Section include:

AS 18.45.030  
AS 35.10.60  
AS 35.10.70  
AS 35.10.170  
AS 35.10.190  
AS 44.42.020  
AS 44.42.055

It is not necessary here to fully describe Research Section activities specifically related to each citation; however, it can be generally said that the research function relates to improving the technology with which the State's capital stock is designed, constructed, operated, and maintained. By the end of 1982, the State of Alaska had public facilities valued at over 5 billion dollars. By maintaining a Research Section to continually assess and improve the technology used in our public facilities the Department helps to protect this investment.

In addition to State of Alaska requirements, the Federal Highway Administration, (FHWA) requires that each state that receives federal aid under cost sharing provisions of the National Highway Fund must maintain an active program of highway oriented research and development.

### 1.3 PURPOSE

The Research Section is a statewide function which supports all regions and divisions of DOT&PF and other state and federal agencies as specified by statute. Within the Section, an active program of technically oriented research and development is maintained with the following goals:

- o Improve the safety and usefulness of transportation systems and public facilities to the user.
- o Improve the serviceability and useful life of transportation systems and public facilities.
- o Reduce the cost of design, construction, maintenance and operations of transportation systems and public facilities.

To accomplish these goals, the Research Section conducts investigative projects applied to specific problems encountered by the Department. The objective is to develop new technical knowledge and apply this knowledge toward a solution. Because of the applied nature of Research Section activities, projects of greatest interest tend to be those which can show benefit to an identified problem in a reasonably short time period, one to three years.

It is appropriate here to make a distinction between the Planning and Research functions as carried out within the DOT&PF. Perhaps the best comparison would be as follows:

**PLANNING:** Collects data and maintains data bases of a general nature concerning state transportation systems and public facilities. This information is then used to investigate the specific needs of the State to plan and prioritize new facilities, rehabilitation of existing facilities, or changes and improvements on a case by case basis.

**RESEARCH:** Collects data and performs investigations of a very specific nature. This information is studied and analyzed in such a way as to identify techniques or improvements which can be of a more general benefit to state transportation systems and public facilities.

A further distinction is that while Planning's function tends to be more broad, encompassing social, political, and institutional issues as well as technical, the Research purview has remained confined primarily to the technical.

An additional mission of the Research Section is to transfer information about new and improved technology to Department professionals. Through publications such as newsletters, reports and other media forms like seminars and workshops, the Research Section supports more than 500 engineers and other technically oriented professionals employed by DOT&PF. These efforts help to inject freshness and innovation into the routine operations of the Department.

#### 1.4 PROCEDURES

As a subdivision of the Department of Transportation and Public Facilities, the Research Section operates under the general policies and procedures applicable to executive branch agencies of state government. The functional organization of the Research Section is shown in Figure 1.4.1.

In addition to general policies and procedures, the Research Section operates under procedures specifically germane to the needs of the Section. These procedures are described in detail in the Research Procedures Manual, Report No. AK-RD-81-18. The most relevant feature of these procedures is the project development process described schematically in Figure 1.4.2.

Ideas for consideration come from a variety of sources, both inside and outside of the Department. These ideas are then developed into a list of proposed research topics which is ultimately submitted to the Research Advisory Board for consideration at the annual board meeting. The Board is annually appointed from within the ranks of the Department. Board members represent the broad interest of the Department mission. They come from all three geographic regions of the Department and differ in professional discipline, experience, and perspective. Together they rank the proposals presented and produce a prioritized list of project subjects that the Research staff can use as a guide in development of an Annual Work Plan.

FIGURE 1.4.1  
DOT&PF RESEARCH SECTION FUNCTIONAL ORGANIZATION

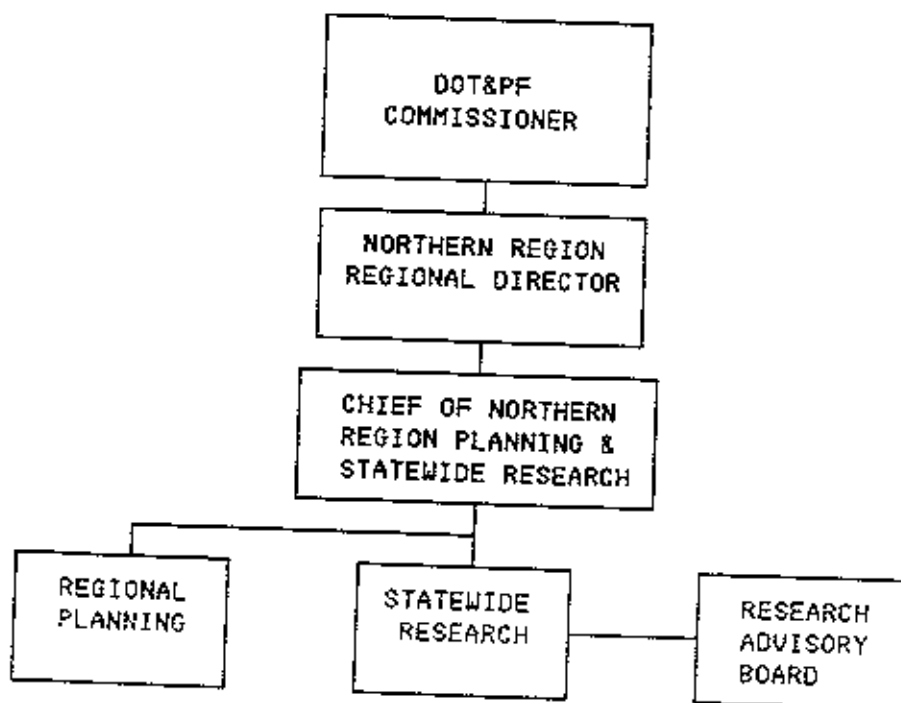
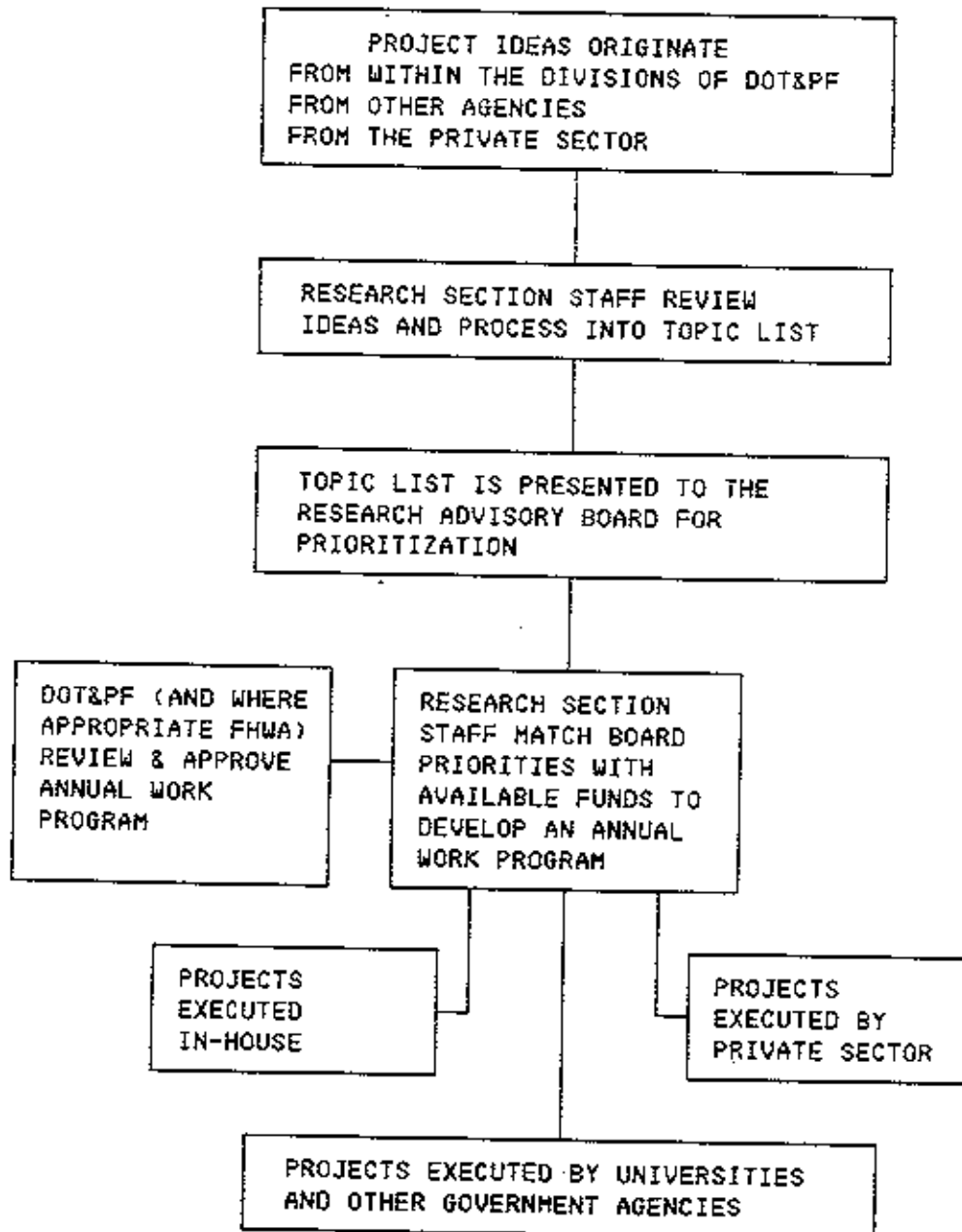


FIGURE 1.4.2  
DOT&PF  
RESEARCH PROJECT DEVELOPMENT PROCESS



For review of research proposals in July of 1986, two boards were convened. One to consider proposals directed toward the Highway Research Program and one to consider proposals directed toward other DOT&PF responsibilities covered by the Facilities Research Program. A list of the 1986 Research Advisory Board members is presented below.

## Research Advisory Board Members for 1986

### Highways:

<u>Name</u>	<u>Division</u>	<u>Region</u>
John D. Horn	Maintenance & Operations	Northern
Steve C. Sisk	Design & Construction	Northern
Joel A. Craft	Maintenance & Operations	Northern (Nome)
Jack R. Morrow	Maintenance & Operations	Northern (Valdez)
Sandy Williams	Design & Construction	Southeast
Richard A. Hamilton	Maintenance & Operations	Southeast
Michael R. Tooley	Design & Construction	Central
J. Steve McKean	Maintenance & Operations	Central
Leo Lutchansky	Information Systems	Headquarters
Bruce R. Freitag	Engineering & Operations	Headquarters

### Facilities:

<u>Name</u>	<u>Division</u>	<u>Region</u>
Bob Venusti	Design & Construction	Northern
Fred Barrett	Maintenance & Operations	Northern
Barbara Urban	Design & Construction	Northern
Richard Royal	Maintenance & Operations	Northern
Harold Moeser	Marine Transportation System	Southeast
Robert H. Wilson	Design & Construction	Central
Ed Thompson	Design & Construction	Central
Loren Rasmussen	Engineering & Operations	Headquarters
Eric Johnson	Statewide Materials Section	Headquarters

With the priorities set by board action, the Research Section staff integrates new projects into a program of continuing projects within the constraints of available funding. This complete program is called the Annual Work Program (AWP). The AWP is then approved by the Department administration, and where federal highway funds are used, by the FHWA. Once approval is given, Research Section staff proceed to develop detailed project scopes, and budgets. From this point work is initiated and the projects managed through to completion.

### Projects are executed in a variety of ways:

- o In-house, using Research Section staff and laboratory facilities.
- o By other Divisions within the Department.
- o By contract to a private company or nonprofit entity.
- o By Reimbursible Services Agreement with another agency or subdivision of State government.

- o By agreement with a non-State of Alaska governmental agency or university.

In all cases, however, the projects are technically managed and fiscally controlled by project managers within the Research Section.

There is one exception to this project development process. From time to time a special need for technical information will arise within a division of the Department. This may take the form of a new product which is being considered for use, but has never been tested and evaluated under Alaskan environmental conditions or similar special need. In such instances, a special project will be developed to address the problem if funds are available. These special projects are normally of very limited scope, can be completed in a relatively short period of time, and have a very positive benefit to cost ratio.

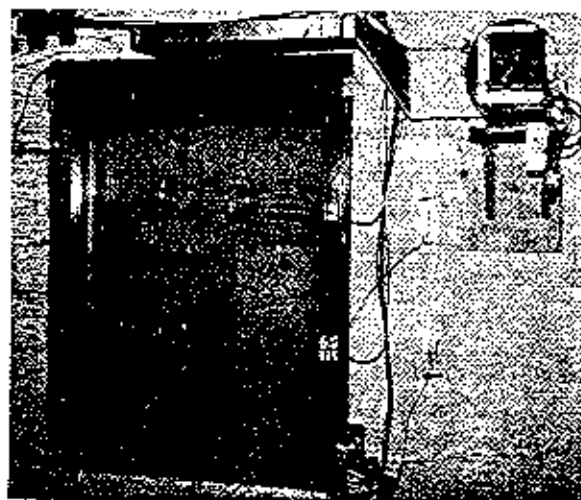
## 2 RESEARCH PROGRAM

### 2.1 FACILITIES AND EQUIPMENT

The Research Program is housed in the Duckering Engineering Building on the University of Alaska campus in Fairbanks. Research occupies approximately 1,750 square feet of office space and shares approximately 5,300 square feet of laboratory, shop, and storage space under a joint-use agreement with the School of Engineering. Shops include carpentry, machine, welding, and staging areas for construction and testing of equipment.

#### Equipment:

Research Program's laboratory and testing equipment include high temperature ovens and low temperature chambers for testing materials under broad temperature extremes, and hydraulic testing machines for tension and compression loading of up to 250,000 pounds. One hydraulic test unit is equipped with an environmental chamber capable of testing samples from -40 degrees Fahrenheit to +400 degrees Fahrenheit.



An "air-flow" window set up for thermal performance testing in the guarded "hot-box."

Environmental chambers include two walk-in cold rooms for testing products down to -20 degrees F., and a 1 cu. meter chamber with a +350 degrees F. to -100 degree F. range. An American Society for Testing Materials (ASTM) guarded "hot box" thermal testing apparatus is used for measuring the effective thermal conductivity of window, door, and wall systems under controlled conditions.

The Research Section owns a gas chromatograph which can be used for a variety of test applications. Most recently it has been used to measure air dispersion in the outdoor environment and air exchange rates inside of buildings.

Facilities permit a variety of soil testing. Common tests include consolidation testing, triaxial strength testing, frost heave testing, and gradation and aggregate soundness tests. A jaw crusher is available for preparation of samples.

The laboratory is equipped for a full range of standard tests for asphalts, including ductility, penetration, viscosity, abson recovery, and mix designs. In addition, the Research Unit has special equipment for indirect tensile testing and for determining resilient modulus of asphalt concrete.

Limited metallurgical testing can be done, including Rockwell Hardness classification, tensile strength determination, and Charpy impact testing. A muffle furnace is available.

A Falling Weight Deflectometer (FWD) is available for pavement condition analysis. Also available are rut measuring equipment and a Mays Ride Meter to determine roadway roughness.

## 2.2 UNIVERSITY OF ALASKA

In addition to the facilities and equipment shared by the DOT&PF Research Section and the University of Alaska School of Engineering, the University is also an important resource for the conduct of Research projects. Through the Research Institutes of the University, such as the Institute of Northern Engineering (INE) and the Geophysical Institute (GI), a large number of the projects are carried out using faculty, staff and students. At the end of 1986, there were over 35 active Reimbursible Service Agreements between the University and the Research Section. These agreements were supporting over 80 man-months of Research faculty effort on DOT&PF projects. These also were supporting 29 engineering student working on relevant research at both the Graduate and Undergraduate level. In this way, the work of the Research Section and the University complement each other and operate in a mutually beneficial manner.

## 2.3 ORGANIZATIONAL CHART

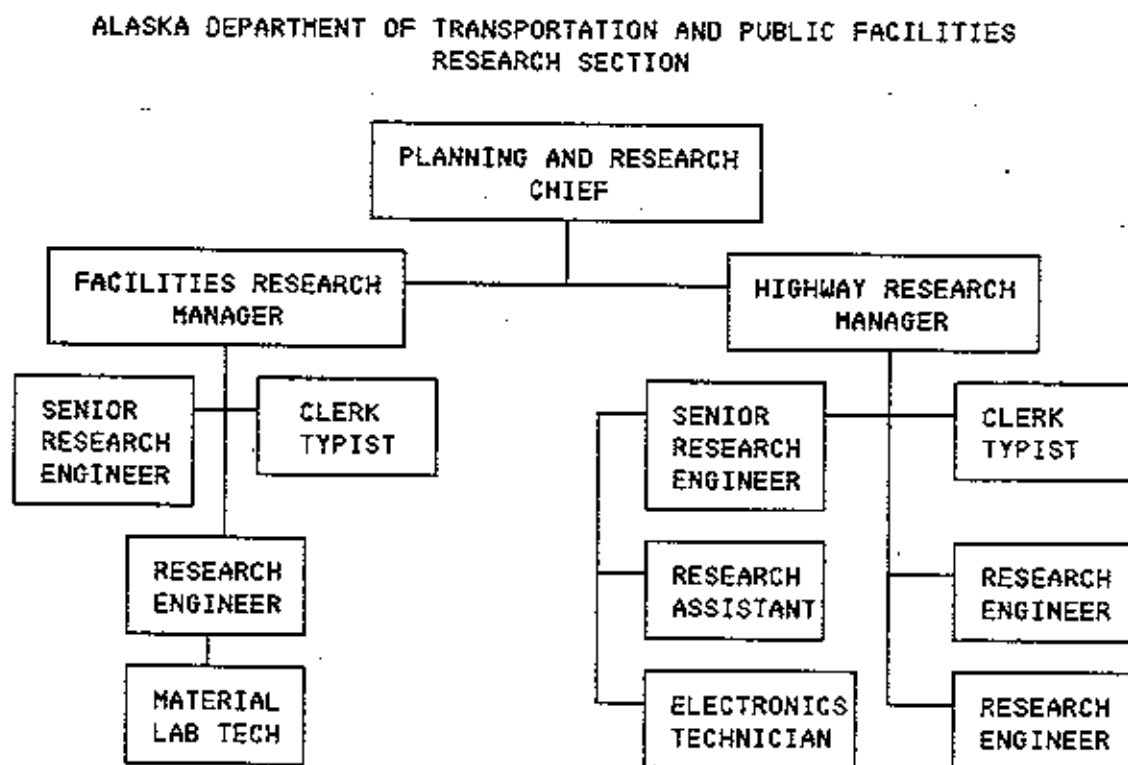


Figure 2.3

## 2.4 STAFF

The organization chart, Figure 2.3, reflects the staffing plan of the Research Section for 1986. The Research Program borrows engineering and technician staff from other divisions of the Department during part of the year. These personnel bring to Research their personal knowledge of problems and often potential solutions to problems they face daily. These exchanges result in implementation of new technologies and a better understanding of areas in which the Research Section can be most effective.

The listing below reflects those persons who worked in the Section for all part or fiscal year 1987.

Dean J. Baldassari  
Lora J. Bobo  
Al B. Brawner, PE  
Richard W. Briggs  
Billy G. Connor, PE  
David C. Esch, PE  
Nikki D. Harlan  
Lorena A. Hegdal, PE (position vacant)

Engineering Assistant  
Clerk Typist II  
Research Engineer  
Electronic Technician  
Senior Research Engineer  
Highway Research Manager  
Clerk Typist III  
Research Engineer

Leroy E. Leonard, PE  
 John D. Martin, PE  
 Carol I. Pederson (position vacant)  
 Matthew K. Reckard, PE  
 John F. Rezek, PE  
 Barbara J. Pineault

Facilities Research Manager  
 Chief of Planning and Research  
 Materials Lab Technician  
 Research Engineer  
 Senior Research Engineer  
 Clerk Typist III

## 2.5 PROGRAMS

### 2.5.1 GENERAL

As implied by the staffing diagram, there are two major divisions within the Research Section regarding programmatic content: a Highways Research Program and a Facilities Research Program. These distinctions are primarily related to basic differences in funding mechanisms and sources, but also correspond, to an extent, with emphasis areas within the Department and specific expertise of staff. The Highway Research Program is the more focused of the two. Similar to highway research efforts in other states, the Alaskan program is part of a nationwide network of state and regional highway research programs, and relies mainly on federal funds available from the FHWA under the Highway Planning and Research Program (HPR) with supplementary funding provided by State of Alaska sources. The Facilities Program is less focused and more diverse in its areas of concern. The Facilities Program is not directly affiliated with an organized federal program and depends mostly on State funding with supplemental funding coming from federal sources, such as the US Department of Energy, on a project by project basis. As with many parallel programs, there is some overlap of subject areas where specific resources make one or the other program the most appropriate for a given project. A breakdown of the major areas of emphasis and the approximated levels of effort applied within the two programs is shown below.

Highways Research	Facilities Research
Bridges & Culverts.....21%	Public Buildings.....22%
Truck Damage Efforts.....20%	Energy & Utilities.....22%
Permafrost Studies.....19%	Marine.....20%
Pavement Design.....14%	Aviation.....19%
Experimental Construction.....6%	Training & Development.....9%
Frost Heave.....6%	Highways.....8%
Highway Safety.....4%	
Training & Implementation.....10%	
Total.....100%	Total.....100%

A more complete description of the programs is presented in the following sections including specific project activities.

## 2.5.2 HIGHWAYS

### 2.5.2.1 OVERVIEW

Highways Research encompasses many different subject areas including safety, experimental construction studies, permafrost research, development of new design methods, and environmental research. Airfield pavement structure and subsurface soils related research is also commonly performed by the Highway Research staff, due to their particular expertise in this area. The Highway Research staffing plan consists of five engineering positions, one electronics technician, and one clerical staff. Typically, University of Alaska students also participate in field and laboratory efforts on a part-time basis, and a computer programmer provides services as needed. This University of Alaska support serves a vital need in allowing staffing flexibility for seasonal work while minimizing costs to the Department.

A breakdown of the Highway Research Program is first made on the basis of funding sources. Federal Highways research funds are received annually on a formula basis through the Highway Planning and Research (HPR) program. Studies conducted with this funding must comply with the Code of Federal Regulations (CFR), and are approved through the Federal Highways Office in Juneau. This program is termed the HPR-Part II Work Program. Other highways related research work is funded with research money from the State's Capital Improvement Projects (CIP) Program. This funding source covered the expenses of 23% of the highway research work done in 1986.

A summary of 1986 research efforts by subject area is as follows:

#### Bridges and Culverts:

Our major research efforts in this area have addressed the question of fish passage requirements versus design standards and other-agency stipulations. Work has focused on springtime upstream migrations of spawning grayling. This program of tracking and quantifying fish movements during periods of high flow through culverts has been accomplished through very successful cooperative work between the DOT&PF Environmental Section; the Department of Fish and Game and the University of Alaska. Major cost-benefits are expected from the newly permitted use of culverts at certain locations in lieu of bridges.

#### Truck Damage Effects:

Load-related damage to roadway pavement structures is being addressed through a statewide Pavement Management Program in which pavement distress is monitored every second year; truck-weighing-in-motion is done to obtain actual load data, and Falling-Weight-Deflectometers (FWD's) are used to measure the seasonal strength variations of roadway structures. With this data, the life of pavements can be predicted under different truck movement scenarios and the costs to the State of Alaska can be forecasted.

### Permafrost Studies:

Seven studies comprise the Permafrost Research Program. Most of the efforts in this area involve long-term monitoring and analysis of different experimental roadway construction features, which were designed to reduce or prevent the thawing of permafrost foundation soils and the related settlement and cracking problems. Insulation layers, peat layers, toe berms, air cooling ducts, and solar screen/snow sheds are all being evaluated under this program. Another significant effort involves the monitoring of deep permafrost temperature trends as a part of the international studies of global warming trends caused by increases in atmospheric "greenhouse gasses." Most of Alaska's facilities located on permafrost are expected to suffer from major long-term distress even if the climate warms only slightly. Thermal model development to allow predictions of the different design features on freezing and thawing of roads and airfields is another important part of this program.

### Pavement Design:

The program of new design method development involves six active studies relating to both highway and airfield pavements. Asphalt and pavement layer properties and fatigue studies, thermal cracking studies, pavement life, field observation, and engineering fabric benefit observations are parts of this program. A new pavement overlay design method is currently being prepared based on use of field strength and performance data in conjunction with elastic layer analysis procedures.

### Frost Heave:

Three active studies are examining frost heaving effects on soils and on foundation piling. A new triaxial confinement cell has been developed for heave testing of confined soils under positive and negative pore water pressures and under different stress states. This equipment will serve to improve the state of knowledge of how frost heave can be controlled or eliminated. A major 3-year study of frost-jacking forces on test piling was completed in 1986. New data were obtained which will assist in the development of improved pile design procedures for frost heaving soils.

### Experimental Construction:

Highway designers occasionally specify new and relatively untested materials or procedures for experimental use in highway construction. The Research Section then monitors and reports on the long-term performance, with assistance when possible from the project construction staff. Currently some 12 experimental features are being actively evaluated, including soil retaining and reinforcing systems, insulation layers, embankment cooling systems, and asphalt modifiers. More than 25 evaluations have been completed and summarized by Research Report 86-14. This program has proven to be an effective means of encouraging designers to try new materials and methods.

## Highway Safety:

Safety-related research has focused on improving wintertime traction and reducing stopping distances through improved sanding procedures and specifications and on the use of more ice-retardant surfacing materials. The development and testing of non-corrosive, de-icing compounds is another component of the safety research program.

### 2.5.2.2 ACTIVE PROJECTS

The HPR-Program of Federal Highway funded highway research for 1986 involved parts of federal fiscal years (FFY) 1986 and 1987. This program is best described by the program status at the close of FFY-86, which ended September 30, 1986. At that time 27 projects were active including six new studies initiated in FY86, along with four administrative and implementation accounts which are required to meet Federal program mandates. These administrative accounts provide for staff salaries for the research manager and secretary positions, and covered the expenses of Experimental Construction Feature evaluations. Various Implementation activity costs including those for presenting, publishing, distributing and promoting the results of previous research studies are also included in this category. The following studies were active in 1986. In addition to HPR funded research, there are several highway projects funded by the State Capital Budget. These are listed under "State Funded Highway Projects." In total, 35 projects are described.

#### HIGHWAY RESEARCH ACTIVE PROJECTS 1986

##### BRIDGES AND CULVERTS:

###### Fish Migration Through Culverts

Advisory Board Priority #4 in 1985  
Project Manager D. Esch

This study of the abilities of migrating grayling to traverse upstream through a highway culvert against various water velocities is being performed in cooperation with the Department of Fish and Game, and is evaluating the culvert design criteria necessary to provide for fish passage at the lowest possible cost.

###### Southeast Hydrology Study

Advisory Board Priority #2 in 1984  
Project Manager D. Esch

This study is providing a hydrological evaluation of high-water streamflow events on Alaska's south and southeast coastal streams, for use in fish migration analysis of culverts and bridge structures.

#### Depressed Invert Culverts

Advisory Board Priority #4 in 1984  
Project Manager D. Each

The benefits are being evaluated of (vertically positioning) culverts more deeply into streambeds so the culvert bottoms can be covered with rock fill for enhancement of fish passage.

#### Fins for Pile Tension (84-11)

Advisory Board Priority #15 in 1984  
Project Manager M. Reckard

The benefits of welding slightly inclined fins onto the lower ends of pipe piles to increase pullout resistance were evaluated in this field study.



16"- diameter test piles.

#### River Training Structures

Advisory Board Priority #11 in 1982  
Project Manager A. Brawner

Three different hydrological computer models for prediction of river and sediment flows were tested and compared against field data from the Tanana River training and control structures near Fairbanks.

## TRUCK DAMAGE EFFECTS:

### Pavement Overlay Design

Advisory Board Priority #5 in 1985

Project Manager B. Connor

Recommendations for a revised and improved overlay design procedure for roadway pavements are being developed and tested under this project, which was initiated at the request of the Federal Highway Administration.

### Performance Life of Overlays (84-4)

Advisory Board Priority #8 in 1983

Project Manager B. Connor

This study established the typical life cycles of pavement overlays in Alaska depending on the previous surface condition.

### Fatigue of Paving Materials (85-4)

Advisory Board Priority #8 in 1984

Project Manager B. Connor

This laboratory study will investigate the fatigue properties of typical Alaskan paving mixtures using test beams and a flexural beam testing machines.

### Dalton Highway Performance

Requested by M&O

Project Manager D. Esch

This study has examined different performance aspects and maintenance problems on the Dalton Highway and to analyze the foundation soils beneath this route for thaw-stability and the feasibility for paving portions of the route.

### Implementation of Falling Weight Deflectometer (FWD)

Departmental Project in 1985

Project Manager B. Connor

This project provided for the purchase of two new Falling Weight Deflectometers which were given to the Regions, along with operator training, maintenance, and pavement analysis training for design engineers. Thereby implementing state of the art pavement testing and analysis.

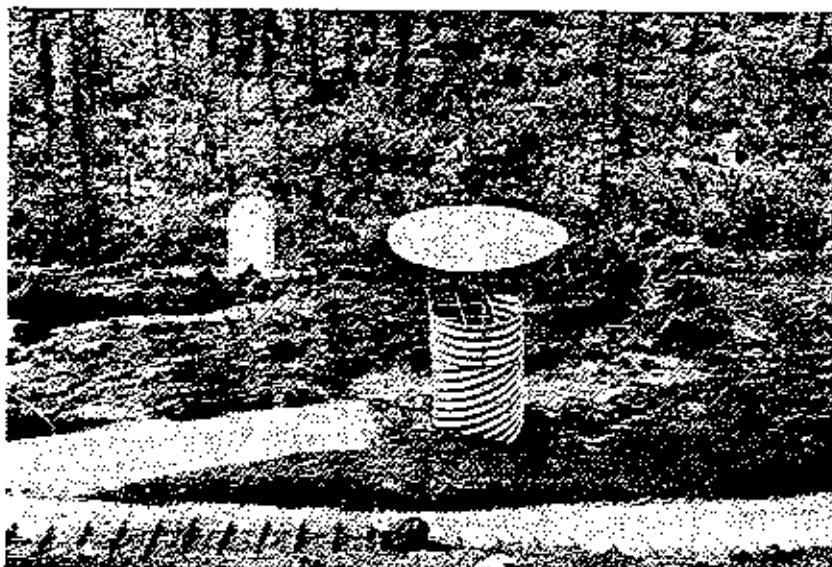
## PERMAFROST STUDIES:

### Gardiner Creek Air Ducts

Advisory Board Priority #5 in 1982

Project Manager D. Baldassari

Field performance studies of experimental air-cooling ducts placed in an embankment on permafrost are being made at an Alaska Highway site near Gardiner Creek.



Inlet and outlet of the experimental air-cooling ducts near Gardiner Creek

### Design Aids for Thermal Analysis

Advisory Board Priority #15 in 1983

Project Manager B. Connor

Various previously developed two-dimensional finite element thermal models were tested and evaluated for use in the engineering design of embankments over permafrost.

### Dynamic Compaction of Sinkholes

Advisory Board Priority #7 in 1984

Project Manager - M. Reckard

Field trials were done in 1984 and evaluated into 1986 to measure the benefits of recompacting existing roadway embankments with a 10 ton drop-weight in areas which have become distorted from thermokarst pits or "sinkholes."

Thaw Stabilization in Embankment

Advisory Board Priority #10 in 1984

Project Manager D. Esch

Field Testing of snow sheds, thermo-syphons, and roadside snow-removal is being done at three sites to measure the benefits of the treatments in reducing roadway slope surface temperatures.

Tensile Reinforcement of Roads

Advisory Board Priority #3 in 1985

Project Manager B. Connor

Field test installations were constituted using different high-strength geosynthetics for spanning subsurface cavities of different widths and orientations, and are being evaluated for creep behavior and long-term strength.

Geotextile Reinforcement over Permafrost

Advisory Board Priority #3 in 1985

Project Manager D. Esch

Multi-layer geotextile reinforced embankments, previously constructed at three roadway locations which have experienced chronic permafrost thaw related distress, are being instrumented and monitored to measure performance over a three-year period.

Heat Transfer Program Development

Advisory Board Priority #7 in 1985

Project Manager B. Connor

A user-friendly one-dimensional thermal model is being developed using the finite difference technique and incorporating surface energy balance consideration.

Permafrost Temperatures and Climate

Advisory Board Priority #5 in 1984

Project Manager D. Esch

Recent national predictions of a global warming trend are of particular concern in Alaska, because much of our road system and several communities are on permafrost very close to the melting point. This project funds University studies which are measuring the warming of permafrost at depth at numerous remote sites where human disturbance is minimal.

Costs of Subsidence From Permafrost  
Advisory Board Priority #11 in 1984  
Project Manager D. Esch

The goal of this study is to determine the percentage of our highway system mileage which rests on permafrost foundation soils, the mileage affected by chronic permafrost related distress, and maintenance and operating costs to Alaskans as a result of the permafrost problem.

PAVEMENT DESIGN:

Evaluation of AC1.75 Asphalt  
Advisory Board Priority #10 in 1981  
Project Manager B. Connor

The long-term pavement thermal cracking resistance benefits of a softer-than-standard grade of asphalt are being investigated in this five-year field testing program.

Prediction of Fines in Base (84-2)  
Advisory Board Priority #7 in 1983  
Project Manager B. Connor

Because controlling the fines contents in the base course layer has proven so critical to good pavement performance, this project was initiated to provide road designers with an appropriate quality criteria for use in estimating the effects of crushing, placement, and compaction on fines contents.

Effects of Salt on Embankments (84-3)  
Advisory Board Priority #10 in 1983  
Project Manager H. Reckard

The consequences of using calcium chloride treatments for dust control prior to paving a roadway were evaluated by field sampling and lab testing in this recently completed study.

Correlation of Modulus with Fines  
Advisory Board Priority #9 in 1984  
Project Manager B. Connor

This study was initiated to develop a method for predicting the elastic properties of untreated pavement structural layers based on the fines contents of those layers, thereby providing a bridge between the old empirical and newer elastic analysis design methods.

Hi-Float Emulsion Paving

Advisory Board Priority #1 in 1984

Project Manager B. Connor

A relatively low-cost roadway surface-treatment method, developed in Canada, is being tested and evaluated with two experimental installations in Alaska.

Pavement Structures over Muskeg (85-3)

Advisory Board Priority #8 in 1984

Project Manager B. Connor

The performance of relatively thin roadway pavement structures over peat-muskeg soils is being evaluated by field deflection testing and elastic analysis of pavements at several Anchorage area locations.

Field Moistures by TDR

Advisory Board Priority #2 in 1984

Project Manager D. Baldassari

A newly developed method of measuring the subsurface unfrozen water contents of soils, termed Time Domain Reflectometry (TDR), was tested by embedding sensors at different depths in pavement structures at several Fairbanks locations.

Investigation of Uncrushed Base

Advisory Board Priority #7 in 1983

Project Manager D. Baldassari

A field and laboratory evaluation was completed in 1986 of two adjacent roadway pavement structures constructed with crushed and uncrushed gravel base course layers, to measure the benefits derived from specifying a fractured particle content for this material.

Asphalt and Aggregate Specifications

Advisory Board Priority #3 in 1980

Project Manager B. Connor

This project involved laboratory study and analysis of the different specifications used for pavements on highways and airfields, and development of recommended contract penalty factors for non-specification base course aggregates.

Cost Effectiveness of Geotextiles  
Advisory Board Priority #1 in 1985  
Project Manager M. Reckard

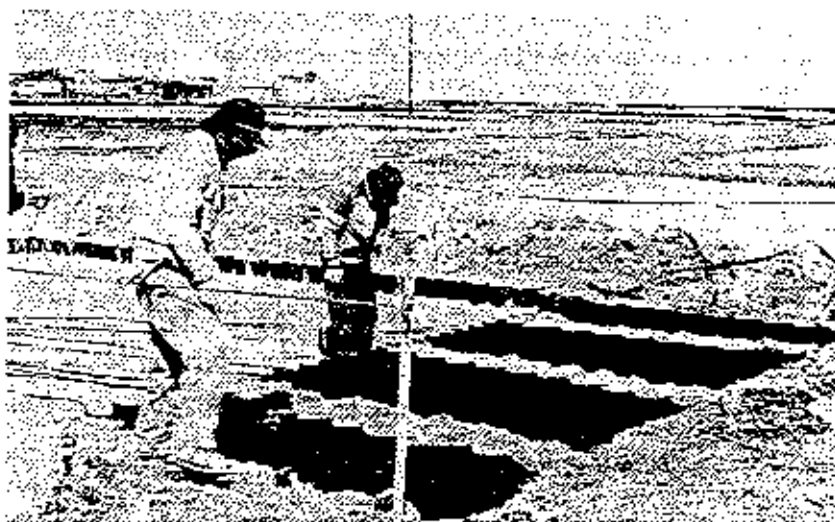
This study is evaluating the benefits of the numerous installations of Engineering fabrics or "geotextiles" which have been made at roadway at roadway construction sites for purposes of reinforcing embankments and separating weak soils from pavement layer materials.

Control of Thermal Cracks  
Advisory Board Priority #14 in 1984  
Project Manager B. Connor

A new pavement section in the Fairbanks area was constructed with sawed crack control joints which were then sealed, to determine whether roadway cracking can be controlled to smooth-walled cracks by pre-sawing.

Shishmaref Geoweb Instrumentation  
Advisory Board Priority #4 in 1984  
Project Manager B. Connor

This study involves instrumenting, monitoring, and evaluating the benefits of the experimental sand confinement grids installed in 1986 to extend the Shishmaref Airport Runway. Work will be completed after load testing in the summer of 1987.



Installation of the experimental sand confinement grids.

## FROST HEAVE:

### Frost Heave Versus Stress

Advisory Board Priority #6 in 1982

Project Manager D. Esch

Laboratory equipment was designed and fabricated to allow lab simulation of actual field frost-heaving conditions, which provide the major advances in the science of predicting, and thereby controlling, the frost heaving of roads, airfields, and building foundations.

### Frostjacking Forces on Piles (84-12)

Advisory Board Priority #17 in 1984

Project Manager D. Esch

Two test piles equipped with strain and temperature sensors and subjected to high field frost-jacking forces were monitored for the 1985-86 winter season and data analysis is being used to provide new information for predicting heave stresses for pole design purposes.

## EXPERIMENTAL CONSTRUCTION:

### Experimental Permafrost Studies

Advisory Board Priority #1 in 1981

Project Manager D. Esch

Various experimental construction features used at six roadway sites and intended to protect roadway embankments from the thawing and settlements of ice-rich permafrost foundations, are monitored and evaluated under this project title.

## HIGHWAY SAFETY:

### Hot Sand Field Trials

Advisory Board Priority #2 in 1985

Project Manager M. Reckard

Three truck-mounted applicators for heating and spreading roadway sand were purchased by the State equipment fleet and their field-effectiveness is being evaluated under this study.

## 2.5.3 FACILITIES

### 2.5.3.1 OVERVIEW

The Facilities Research Program addresses the physical and technical problems of all non-highway facilities of the Department and supports other State departments according to statute. The Facilities staff also handles some highway oriented projects for which staff members are uniquely qualified but the major effort is on other modes of transportation and the non-transportation capital assets of the State for which the Department has responsibility.

At the end of 1986, the program was staffed with five approved positions as shown by the staffing chart. This is a significant reduction over past years and reflects the decline in State revenue experienced over the past few years. In spite of these reductions through attrition and personnel transfers, a vigorous program of research projects was undertaken. The elements of the program were shown in Section 2.3.1 with a corresponding level of effort listed as a percentage of total program effort. A brief description of these program elements with some explanation as to why they are covered follows.

#### Buildings:

The State of Alaska owns and operates over 2300 buildings of all descriptions throughout the state. These buildings contain over 17,000,000 square feet of floor space and would have a replacement value conservatively estimated at more than two billion dollars. The annual repair maintenance cost alone can vary from 2 to 10 million dollars, and this figure does not include any janitorial or operations costs. The Facilities Research Program of DOT&PF is the only state supported effort remaining which is actively working on standards, procedures, new materials and techniques, and design and construction developments directed toward state buildings. To what extent Alaska will be able to maintain and operate its vast and scattered inventory of buildings in the future, largely depends on developing new ways of doing things. The harsh environment of Alaska places stresses on our buildings, unlike anywhere else in the nation, from the foundation to the roof. The State, therefore, is alone in developing ways to deal with these problems.

#### Energy and Utilities:

The more than 2,300 buildings in the state's inventory must be continually supplied with heat, electricity, water, and sewer. The harsh environment and remote logistics of Alaska make this a most difficult and expensive task. These state buildings can easily consume over 10 million gallons of fuel oil and perhaps 15 million dollars worth of electricity annually. Attempting to reduce these energy costs through conservation methods and improved energy efficiency of mechanical and electric systems is a major focus of Facilities research. Our R&D projects are coordinated with public and private agencies, such as the Alaska Power Authority and the Alaska Village Electric Cooperative, to try and maximize the technical effort and gain perspective into the serious technical problems that

exist. Inefficient diesel generators and poor power quality add perhaps several million dollars a year to the state's cost of repair and operation in rural areas. Several of our projects address this problem and we are one of the few organizations in the nation studying the problems of small electric power systems. Power outages, especially in the bush, each year cost the state significant amounts in repair of freeze damage to utilities and plumbing. Fire is always a threat in the bush, and the Facilities programs attempts to address these problems as well by adapting fire protection and control technology to the Alaskan conditions.

#### Marine:

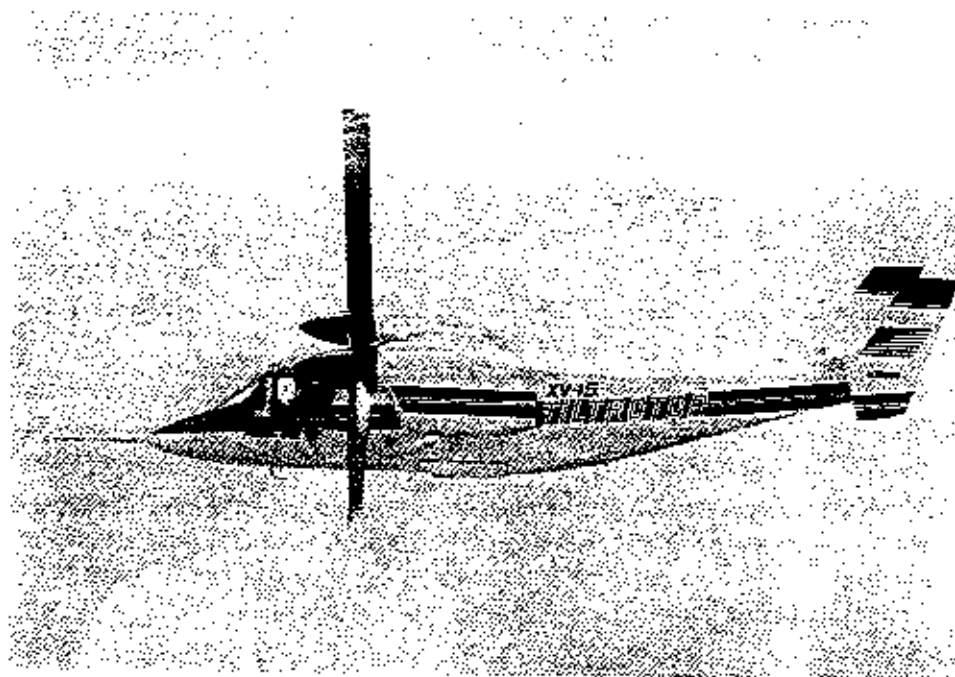
Alaska, unlike other states, operates its own transportation system connecting with both the contiguous state and Canada. This system accounts for a tremendous investment in ocean-going vessels and port and harbor facilities that Alaska owns, operates, and maintains in the Alaska Marine Highway System. The Marine Highway System alone accounts for approximately 40% of the DOT&PF operating budget. The Facilities Research Program works with the Operations Engineering sections of the Marine Highway System as well as the ports and harbors staff's of Design and Construction in the various regions. The focus is mainly on reducing continuing costs. Currently, this is a major area of concern for the Facilities Research Program, and we hope to strengthen our support in the future.

#### Training and Development:

The Facilities Research program manages a graduate student assistantship program in Engineering at the University of Alaska in Fairbanks. Students work on specific engineering problems faced by DOT&PF as part of their graduate study program. This is one of our most cost effective projects. This portion of the program also provides for costs incurred to publish and circulate reports and publications, and conducts seminars and workshops, all of which transfer the technology developed by the research and development process to others throughout the state both inside and outside of DOT&PF.

#### Aviation:

The State of Alaska is also unique in that it owns and operates over 200 airports throughout the state. This is many times more than any other state and represents tens of millions of dollars invested. The ongoing operation and maintenance costs of these facilities and their support systems are ever-increasing burdens on state revenues. Particularly in rural Alaska, the safety record of air transportation falls far below that of the rest of the nation. Our research and development projects are aimed at both decreasing these costs and improving the safety of air transportation wherever possible through innovative technology. New ideas about runways, navigation and landing aids, airfield lighting, weather information dissemination, and potentially useful developments in aviation are continually investigated.



Once experimental, Tiltrotor aircraft may soon be used commercially in Alaska, eliminating the need for long runways in rural communities.

#### Highway Research:

Although the bulk of highway research and development projects are handled under the Highways Program, there are currently two active projects in which the Facilities Program is supplementing the Highways Program. Carbon Monoxide pollution in both Fairbanks and Anchorage (both cities are designated by EPA as non-compliance areas) continues to threaten our federal highway dollars as well as our cardiovascular systems. Our research in air pollution modeling is aimed at providing planners and Design and Construction with better tools to predict CO impacts when modifying the urban highways or the traffic control systems. Such work should minimize environmental impacts and help keep us within compliance with EPA regulations.

Another project is aimed at improving communication systems used by maintenance personnel along the vast expanses of Alaska's highways. Existing two way radio systems are limited by several factors which have a direct impact on our annual maintenance budgets. Improvement in communications could result in significant benefits.

#### 2.5.3.2 ACTIVE PROJECTS

At the close of calendar year 1986 the Facilities Research Program was conducting 22 active research projects. The majority of these projects were begun in previous years and have continued in 1986. Only three new projects were begun in 1986.

FACILITIES RESEARCH  
ACTIVE PROJECTS 1986

BUILDINGS:

Moist Insulation Study

Advisory Board Priority #4 in 1982

Project Manager J. Rezek

This study is identifying moisture problems with various building insulation materials in an effort to prepare better specifications for design and construction of state buildings.

Building Air Quality

Advisory Board Priority #8 in 1982

Project Manager J. Rezek

This project has been an ongoing effort to learn more about indoor air quality in our state owned and operated buildings. Air exchange rates, effects of humidity, and pollutants such as carbon monoxide and cigarette smoke have been studied. Currently, under this project, we are studying the risk of Radon gas exposure in public buildings.

Thermal Performance Standards

Legislative Intent 1980

Project Manager L. Leonard

Development of thermal and lighting energy design standards were completed in 1984 for State buildings with less than 12,000 ft<sup>2</sup> of floor area. Currently, this project is reaching completion of standards for larger buildings.

Mechanical Engineering Guide

Advisory Board Priority #9 in 1984

Project Manager L. Leonard

This project supports DOT&PF Standards and Technical Services by developing standards for the design and construction of mechanical systems in state buildings. These are necessitated by the large number of failures experienced over the years.

Thermal Test Chamber M&O

Advisory Board Priority #10 in 1984

Project Manager J. Rezek

This project provides for maintenance and incidental operational costs of the section's Guarded-Hot-Box. This apparatus is used to measure the thermal conductivity of building materials and components. See Newsletters Vol. 5, No. 12, dated June 1986; Vol. 5, No. 6 dated December 1985; Vol. 5, No. 4, dated October 1985; and Vol. 3, No. 5, dated 1983.

### Roofing Materials

Legislative Intent/1981

Project Manager J. Rezek

This project is developing improved specifications and design and construction techniques for roofs of state owned and operated buildings. The project is the result of a large number of failures of roof systems of State buildings observed over the years.

### Snow Load Manual

Advisory Board Priority #3 in 1985

Project Manager J. Rezek

This project is a joint effort of several state agencies to develop more accurate design information about snow loads on roofs in various parts of the state.

### Refrigerated Foundation Systems

Advisory Board Priority #1 in 1981

Project Manager J. Rezek

This project is evaluating the heat removal rates of commercially available thermal tubes for fixed conditions and at various angles. The results may be applied by engineers designing foundations in permafrost conditions which are to be stabilized using heat tube technology.



Test facility for evaluation of heat transfer from thermo tubes at CRREL's Hanover, New Hampshire lab.

## ENERGY AND UTILITIES:

### Diesel Electric Fuel Economy

Legislative Intent/1980 & Advisory Board Priority #2 1985

Project Manager L. Leonard

Diesel-Electric systems, used to supply electric power to many public facilities, are investigated and analyzed both in the field and the laboratory to find ways of improving reliability and fuel economy. The information is used to develop improved design standards, specifications, and maintenance and operation procedures.

### Power Quality

Legislative Intent/1980 & Advisory Board Priority #5 in 1985

Project Manager L. Leonard

Irregularities in signal quality from diesel-electric generators cost the state significant amounts annually for maintenance and repair. This project seeks to identify the source of these problems, quantify the costs, and find cost effective solutions to the problem.

### Photovoltaic Systems

Special Project

Project Manager J. Rezek

This project is evaluating a working photovoltaic system and analyzing the data collected. The results will be prepared so as to be readily usable by engineers contemplating the photovoltaic power alternative.

### Bush Fire Protection

Advisory Board Priority #12 in 1985

Topic reevaluated as "of special importance" by 1986 Board

Project Manager J. Rezek

This project is investigating alternatives to water sprinkler systems for fire protection of facilities in bush Alaska. The object is to improve the reliability of protection and to reduce the time and cost of repair in the event of a fire. An emphasis is being placed on modified Halon systems.

## MARINE:

### Loading of Float Connections

Advisory Board Priority #1 in 1983

Project Manager J. Rezek

This project is investigating the failure of finger float connections at the Kodiak small boat harbor and will attempt to find a solution to the problem.

#### Seaway Quantification

Advisory Board Priority #5 in 1984

Project Manager J. Rezek

This project supports the Marine Highway System by developing sea-state data and improving coastal navigation techniques which may allow the use of smaller, less expensive vessels for local ferry traffic in southeast Alaska as part of the new Fast Ferry System.

#### Twin Hull Stability

Advisory Board Priority #5 in 1985

Project Manager J. Rezek

This project is developing stability criteria for use of light, fast, twin hull vessels to be considered for use as part of the Fast Ferry System. This information will help assure that vessels purchased will be the safest and most cost effective available.

#### AVIATION:

#### Radioluminescent Edge Lights

Advisory Board Priority #1 in 1984

Project Manager L. Leonard

As a joint effort with the US Department of Energy under this project a non-electric air field lighting system has been developed. Currently the system is in use at three rural airports. This is an extension of tritium light technology using the hydrogen isotope tritium as an energy source. See also Implementation, Section 4.1.

#### Bethel Bump Phase III

Advisory Board Priority #1 in 1985

Project Manager J. Rezek

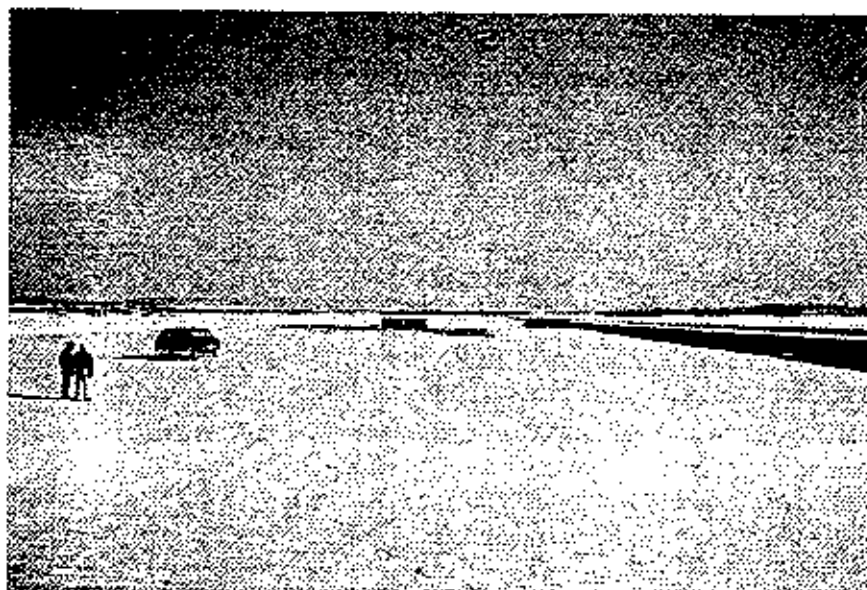
This is an experimental project which is stabilizing a bump in the runway at Bethel airport using heat-tube technology. So far the project has been successful in delaying the need for major reconstruction which would be a major disruption of service and cost many times the cost of this project.

Ba-Vasi

Special Project Requested by D&C

Project Manager L. Leonard

This is a project directed toward improving aviation safety on small or remote runways. We are testing an inexpensive, low maintenance visual glide slope indicator. We are currently evaluating pilot acceptance of a unit installed on a secondary runway at Fairbanks International Airport.



BA-VASI. Simple and inexpensive. The BA-VASI is being evaluated at Fairbanks International Airport, but will support aviation primarily in rural communities.

TRAINING AND DEVELOPMENT:

Engineering Student Program

Legislative intent/1981

Project Manager L. Leonard

This is a very cost effective program which allows graduate students in Engineering at the University of Alaska to fulfill their research project requirement by studying a subject of interest to DOT&PF. At the end of 1986 there were three students supported by this program, one in each of the Civil, Mechanical, and Electrical engineering disciplines, with a fourth scheduled to begin in the Spring of 1987 in Mechanical Engineering.

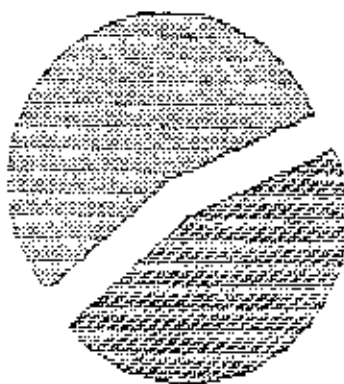
### 3 FINANCIAL

#### 3.1 TOTAL FUNDING

In 1986 funding to support the Research Section was derived from both State of Alaska and Federal sources. These source divisions are shown in Figure 3.1 followed by a breakdown of the sources in Table 3.1.

FIGURE 3.1

### DIVISION OF FUNDS



STATE  
FEDERAL

TABLE 3.1  
TOTAL FUNDS FOR RESEARCH SECTION 1986

	STATE GENERAL FUND	FEDERAL FUNDS
STATE OPERATING BUDGET	\$424,900.00	
STATE CAPITAL BUDGET	\$500,000.00	
FHWA HPR PROGRAM		\$640,000.00
FHWA RTAP PROGRAM		\$62,500.00
U.S. DEPT. OF ENERGY		\$52,000.00
SUBTOTAL	\$924,900.00	\$754,500.00
TOTAL	\$1,679,400.00	

Administration of Facilities Research  
Project Manager L. Leonard

This project supports the costs for publication of reports, seminars, workshops, and similar activities. It also supplements other projects with minor funding adjustments necessitated by unforeseen contingencies.

HIGHWAY:

Direct Satellite Communications  
Advisory Board Priority #6 in 1984  
Project Manager L. Leonard

This investigation is conducted through the Institute of Northern Engineering at the University of Alaska. It focuses on methods using orbiting satellites and portable ground receivers which would support continuous coverage for voice grade communications along the expanses of land and marine highways in Alaska.

Atmospheric Pollutant Transportation Model  
Advisory Board Priority #3 in 1983  
Project Manager L. Leonard

This study focuses on the implementation of Caline4, a line source Gaussian model, to predict CO levels in ambient air. The existence of high CO levels in Alaska makes it critical to be able to assess the impacts of highway projects on this air quality parameter. Our approach involves the assimilation of existing meteorological and traffic data in Fairbanks and Anchorage so that we can assess the suitability of Caline4 in Alaska. It supports the environmental sections of D&C in Fairbanks and Anchorage.

### 3.2 OPERATING BUDGET

A portion of the funds to annually support the Research Section are appropriated to the Department by the Legislature through the Operating Budget. The Operating portion supports primarily overhead and administrative costs and about half of the staff salaries. In 1986 the Operating Budget for the Research Section was as follows:

TABLE 3.2  
OPERATING BUDGET

<u>OBJECT DESCRIPTION</u>	<u>GENERAL FUND APPROPRIATION</u>
Personnel Services (salaries)	\$353,800
Travel	2,600
Contractual Services	61,100
Commodities	7,400

Authority to expend up to \$350,000 of additional Federal receipts on Personnel Services, was also provided by the Legislature in the 1986 Operating Budget.

This appropriation represents over a 20% Real-dollar decrease from the previous year.

### 3.3 CAPITAL BUDGET

As shown in Table 3.1 funds were also appropriated to research through the State Capital Budget. These funds are used to conduct the Annual Work Program of projects. Also, through the Capital Budget the Legislature grants limited authority to the Research Section to Receive and Expend federal funds. In 1986 the Legislature appropriated \$500,000 from the General Fund Capital Budget to support research projects within DOT&PF.

In the same budget, authority to receive and expend federal funds was given in the amount of \$750,000.

Figure 3.3 shows the allocation of the general fund dollars with Research Section at the end of 1986. Immediately following Figure 3.3 is Table 3.3 which identifies the total project breakdown of these capital funds.

At the end of 1986, there remained several projects from this list that were not yet initiated. This was necessitated by the failure of the National Highway Act pass the US Congress at the close of the 1986 session. Since the greater portion of the federal funds, described above, were part of that legislation it seemed prudent that some funds be held in reserve pending final resolution of the issue.

FIGURE 3.3

## 1986 GENERAL FUND CAPITAL BUDGET

(Thousands)

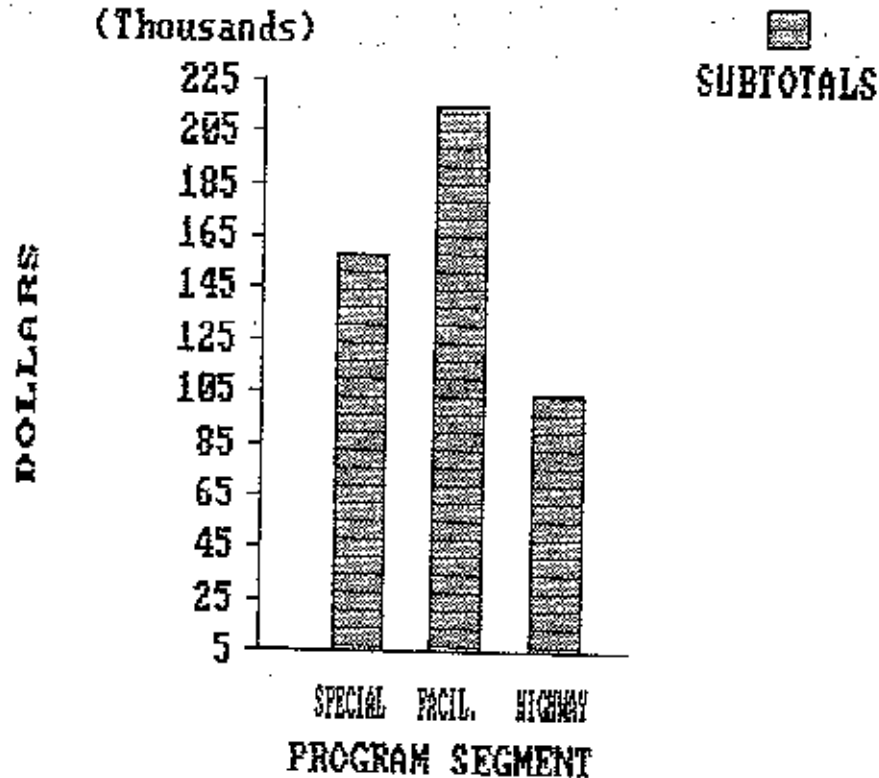


TABLE 3.3

PROJECT	SPECIAL PROJECTS	FACILITIES	HIGHWAYS
NEW PRODUCTS TESTING	\$15,000.00		
FAILURE STUDIES	\$30,000.00		
PUBLICATIONS	\$55,000.00		
IMPLEMENTATION	\$28,000.00		
COMPUTER PROGRAMING	\$5,000.00		
STUDENT PROGRAM	\$25,000.00		
SEAWAY QUANTIFICATION		\$125,000.00	
TWIN HULL STABILITY		\$24,000.00	
HANICAP ACCESS SYSTEMS		\$45,000.00	
HALON FIRE PROTECTION		\$22,000.00	
SPRING THAW DAMAGE			\$45,000.00
STATEGIC HIGHWAY RES.			\$5,000.00
ROADSIDE VEGETATION CNTL.			\$54,000.00
SUBTOTALS	\$158,000.00	\$216,000.00	\$104,000.00

### 3.4 FEDERAL FUNDING

As has been discussed in other sections of this report, the Research Section depends heavily on federal funding, especially for the Highway Research program. As was made clear by Figure 3.1 federal funding is critical to the operation of the Research Section accounting for about 44% of total funding. In 1986, however, the lack of a National Highway Act placed the Highway Research Program in some jeopardy. Of greatest concern was the largest block of funding for research, the \$640,000 earmarked for the HPR program was included. Although this was resolved in the spring of 1987 at the end of 1986 the uncertainty was causing serious disruption in the orderly conduct of the Research program. For this report however, we will not deal with the issue further.

The designated allocation of federal funds within the Research Section is shown in Figure 3.4 and Table 3.4.

FIGURE 3.4  
1986 FEDERAL FUNDING ALLOCATIONS

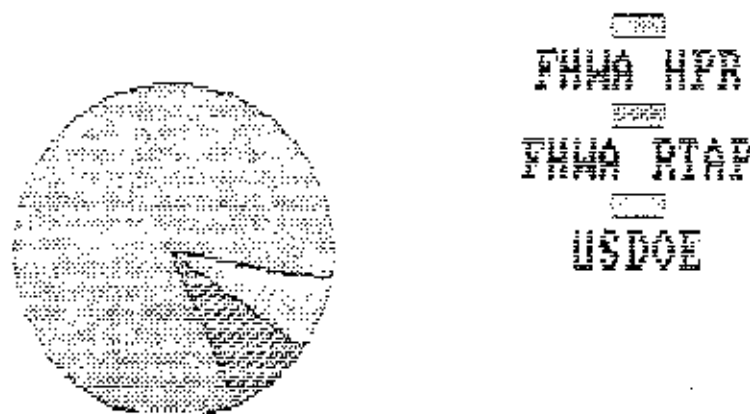


TABLE 3.4  
DESIGNATED ALLOCATION OF FEDERAL FUNDING 1986

	FEDERAL PROGRAM		
	FHWA HPR	FHWA RTAP	USDOE
HIGHWAY RESEARCH STAFF SALARIES	\$350,000.00		
HIGHWAY RESEARCH CONTINUING PROJECTS	\$200,000.00		
HIGHWAY RESEARCH NEW PROJECTS	\$50,000.00		
TECHNOLOGY TRANSFER CENTER		\$62,500.00	
FACILITIES RESEARCH NEW PROJECTS	\$40,000.00		
FACILITIES RESEARCH CONTINUING PROJECTS			\$52,200.00
SUBTOTAL	\$640,000.00	\$62,500.00	\$52,200.00
TOTAL			\$754,700.00

## 4 RESULTS OF RESEARCH

### 4.1 IMPLEMENTATION

As described earlier, the primary goal of Research projects, is to develop new knowledge about some aspect of the Department's mission associated with planning, design, construction, maintenance, or operations, and with that knowledge affect a positive change. The process of translating that new knowledge into the positive change we most often refer to as implementation. The results of a research project, no matter how skillfully executed or innovatively contrived are of little direct value to the Department unless they can be implemented into the routine operation of some aspect of the department's work. For this reason considerable emphasis is placed on implementation.

All projects undertaken by the Research Section are performed with the ultimate goal of resulting in something which can be implemented. Each project report contains an Implementation Statement which relates the work described to the implementation issue. In many cases an entire project is aimed at implementing the results of some previously completed research project.

The following describes two efforts which began in the Research Section as ideas and were carried through the various stages eventually resulting in positive change. While there are numerous examples of implemented research results, some more significant than others, these two were accomplished in 1986 and serve as relevant examples.

#### THE IMPLEMENTATION OF RADIOLUMINESCENT RUNWAY LIGHTING

In 1980 representatives from the Alaska Region of FAA visited the Research Section to discuss the problem of limited landing aids at small rural airports. The Department owns and operates over 200 airports statewide with the vast majority equipped with minimal support facilities because of low volume use and remoteness. Among other topics, the discussion of airport lighting was of prime interest. Although the Research Section was beginning to consider the issue through projects, no clear alternative to conventional, medium intensity, electric runway lighting was envisioned, and all agreed that the cost and reliability problems associated with remote locations did not present an attractive solution.

By 1982 the Research Section had investigated a number of remote runway lighting alternatives, but all were fundamentally electric and all had the drawback of requiring a reliable and continuous electric power source. It was the power source that presented most of the problems in remote areas, so we began to look for a non-electric alternative. In January of 1983 the Research Section conducted a joint experiment in Alaska with the US Department of Energy and several branches of the military in which Radioluminescent (RL) technology, tritium lights, could be adapted to a non-electric runway lighting application. The test was a qualified success and the following year a two-month demonstration was conducted at the state airport at Central, Alaska with a second generation prototype lighting system. In 1984 a further improved system was evaluated by the FAA Tech Center resulting in a favorable report.

Further testing in Alaska was conducted. While less intense than conventional electric runway lighting, the 100% reliability of RL lighting and its proven ability to support VFR night operations at small rural runways has convinced the Department of its value. In December 1986 Deputy Commissioner H. Glenzer informed the Alaska region of FAA that three permanent RL lighting systems had been permanently installed at State operated airports at Central, Council, and Tununak. Although certain regulatory approvals are yet to be fully obtained and continued, joint testing by the Research Section and the USDOT will continue to assure the ultimate safety and longevity of the systems RL's have now been implemented.



Installation of RL runway lighting at the Central airport.

Currently, the RL's can be purchased and installed in many cases for less than half the cost of the electric alternative with the life cycle cost comparison even further slanted toward the new system. The Alaskan systems were the first of their type in the world. Currently the Alaska Air Command of the USAF is procuring RL systems to support its special mission in Alaska, and the State of Florida is leading the development of RL taxiway signs and taxiway edge lighting for its unique problems. RL technology will continue to advance and the Department will share in this evolution but, at the current state-of-the-art the implementation of RL runway lighting is making a positive contribution to the safety and viability of aviation in Alaska.

#### THE IMPLEMENTATION OF THE FALLING WEIGHT DEFLECTOMETER

During the 1960's highway engineers realized that insitu strength measurements of highways provided the most accurate means of predicting the life expectancy of pavements. The Benkleman Beam procedure, which involved measuring the vertical movement beneath the tires of a loaded truck, became widely used to indicate pavement strength. This deflection

was then successfully correlated with the pavement life. Data from test roads allowed deflection data to be used to design pavement overlays which would perform in a more predictable manner than previous methods allowed.

Elastic layer theory showed that if the shape of the deflection "basin" could be determined, the strength characteristics of the soil that support the wheel loadings could be determined. This would provide the mechanism to further improve the predictability of pavement performance.

In 1977, the Department purchased a Road Rater, a machine which worked much like the Dynaflect. The Road Rater was extensively tested by the Research Section and found to be unsatisfactory for use in Alaska for several reasons. First, the loads were not high enough to adequately model loads by heavy trucks directly. Secondly, during spring thaw, the vibratory load used by the Road Rater caused the deflection measurements to be unusable.

During the summer of 1980, a consultant was contracted to test a new device called the Falling Weight Deflectometer (FWD). The FWD simulates a passing truck by dropping a weight onto the pavement surface and measuring the deflection of the surface at predetermined distances from the load. This allowed the measurement of the pavement response under the same loading conditions as would be expected under heavy wheel loads. Operators can "dial" in the load they want and monitor what happened. The Research Section staff was sufficiently impressed that a FWD was purchased in 1981. The FWD was immediately used to collect deflection data for use in planning, design and for the establishment of load restrictions. While deflection data had been required, for many years in the design of overlays, the FWD reduced the cost of collecting this data by approximately 75% as compared to the previously used Benkleman beam. It also allowed the system-wide coverage needed for accurate planning and design process.

By 1984, the increased demand for the FWD required the purchase of an additional machine to be stationed in Anchorage. As experience with the deflection data increased, new methods were developed nationally and by the Research Section which have allowed pavement design to move from an art to a science. For the first time, pavements are being designed using engineering parameters rather than empirical equations. Personnel skilled in these techniques are able to predict pavement performance for designs and materials which are outside their experience. Many of these designs have greatly reduced the cost of roadway rehabilitation projects. In some cases, failures of pavements produced under the previously used procedures have been accurately predicted.

Demand for the FWD continued to grow until two additional machines were purchased in 1986. Two machines are currently in Fairbanks, one in Anchorage and one in Juneau. Several training courses have been given to highway and airport designers, both within the Department and the private sector, to provide the knowledge to use the deflection data to the full state-of-the-art. The Department's engineers are beginning to realize that pavement structures can be analyzed in a manner similar to the way structural engineers have been analyzing buildings for many years.



The implementation of the Falling Weight Deflectometer into the Department has resulted in a major change in the way highway and airport pavement structures are designed. Current springtime load restriction policy relies heavily on the FWD to determine when and where to apply load restrictions. Deflection data is also consulted whenever overweight permits are requested in excess of 125% of the legal limit to insure that the roadway can withstand the load without undue damage. In short, the FWD is becoming integrated into all aspects of pavement planning, design, maintenance and pavement protection.

#### 4.2 TECHNOLOGY TRANSFER

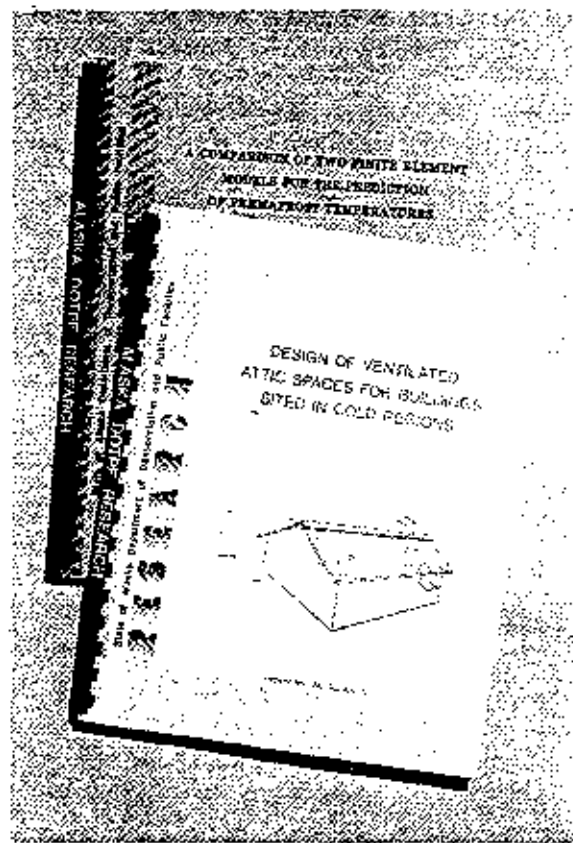
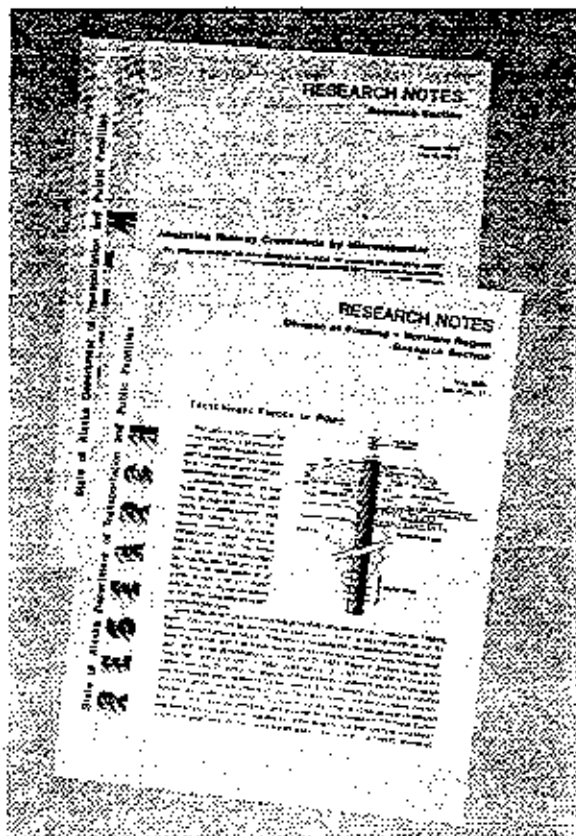
In June of 1986, Alaska received a grant to establish the Alaska Transportation Technology Transfer Program as part of the Federal Highway Administration's Rural Technology Assistance Program (RTAP). This program provides a technical resource to Alaskans facing the many challenges of transportation needs. While the focus of Research has been to meet Department needs, this program provides funding to broaden our audience and offer assistance in improving transportation expertise at the local level as well as within DOT&PF.

Under this program, we conduct up to ten seminars per year and produce a quarterly newsletter. Seminar subject areas include: administration, planning, maintenance, operation, design, and construction of transportation facilities. During the past year, seminars were conducted in Fairbanks, Anchorage and Juneau.

This program is underwritten by a \$62,500 federal grant. The required 50% match for this grant is provided jointly by the DOT&PF and the University of Alaska, Fairbanks.

#### 4.3 PUBLICATIONS

The Research Section prepares and distributes publications in two basic formats as shown in the following photos.



RESEARCH NOTES are newsletters published monthly which highlight one or more research projects of topical interest being carried out by the Research Section. The format is informative usually without being highly technical. RESEARCH NOTES is distributed to a 335 member mailing list free of charge. Those interested in receiving RESEARCH NOTES on a regular basis can do so by contacting the Research Section and requesting that their name be included on the mailing list.

RESEARCH REPORTS are the official documented record of a project conducted by the Research Section. This formal report series was begun in 1980 and currently contains 182 listings. Reports are bound in the Research Section's cover and numbered with the AK-RD designation. The format is typed and the length and degree of technical complexity varies

considerably depending on subject. The contents of reports reflect the views of the author who is responsible for the facts and accuracy of the material. Each report, however, contains an Implementation Statement which is the official view of the Research Section as to how the content of the specific report relates to the DOT&PF.

RESEARCH REPORTS are intended for distribution to and use of DOT&PF personnel, but it is recognized that many reports are of significant interest to others. After distribution within the Department, it is the policy of the Section to make remaining copies available to interested parties without cost, once the internal distribution has been made. Reports are cataloged at State libraries and the University of Alaska. When stocks are depleted, requests are referred to the Arctic Environmental Information and Data Center, University of Alaska, 707 A Street, Anchorage, Alaska, 99501, or by phone (907) 279-4523.

In addition to our standard distribution in 1986, the Research Section distributed requested materials as follows:

#### RESEARCH REPORT REQUESTS:

7/85 to 12/86

Foreign - 133

Out of State - 246

In State - 617

TOTAL REQUESTS - 996

Publications distributed in 1986 are listed below. A complete list of publications produced since July 1, 1980 is available by writing the Research Section.

#### RESEARCH NOTES

##### DIRECT SATELLITE COMMUNICATIONS

November 1986, Volume 6, Number 5, Alex Hills.

##### UPDATE: RADIOLUMINESCENT LIGHTS

October 1986, Volume 6, Number 4, Leroy E. Leonard.

##### DIESEL ELECTRIC GENERATOR

September 1986, Volume 6, Number 3, Leroy E. Leonard.

##### ANALYZING RUNWAY CROSSWINDS BY MICRO COMPUTER

August 1986, Volume 6, Number 2, Alan Braley.

##### SAND STABILIZATION FOR ROADS AND AIRFIELDS

July 1986, Volume 6, Number 1, David Esch.

##### EGRESS WINDOW TESTING

#### EGRESS WINDOW TESTING

June 1986, Volume 5, Number 12, John F. Rezek

#### FISH PASSAGE THROUGH DRAINAGE STRUCTURES

May 1986, Volume 5, Number 11, Larry R. Sweet and Michael Travis

#### BRIDGE FOUNDATIONS IN PERMAFROST

April 1986, Volume 5, Number 10, Dean Baldassari

#### ICEBREAKER TRAFFICABILITY STUDIES

March 1986, Volume 5, Number 9, Larry R. Sweet

#### THERMOSYPHON DEVICES

February 1986, Volume 5, Number 8, Lorena Hegdal

#### DYNAMIC COMPACTION

January 1986, Volume 5, Number 7, Matthew K. Reckard

#### RESEARCH REPORTS

REPORT NUMBER	TITLE
---------------	-------

AK-RD-86-31	Vita, Charles L., Vinson, Ted S., and Rooney, James W., Bethel Airport CTB-AC Pavement Performance Analysis, 74 pp., 1986.
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AK-RD-86-30	Danyluk, Lawrence S., Stabilization of Fine-Grained Soil for Road and Airfield Construction, 42 pp., 1986.
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FHWA-

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